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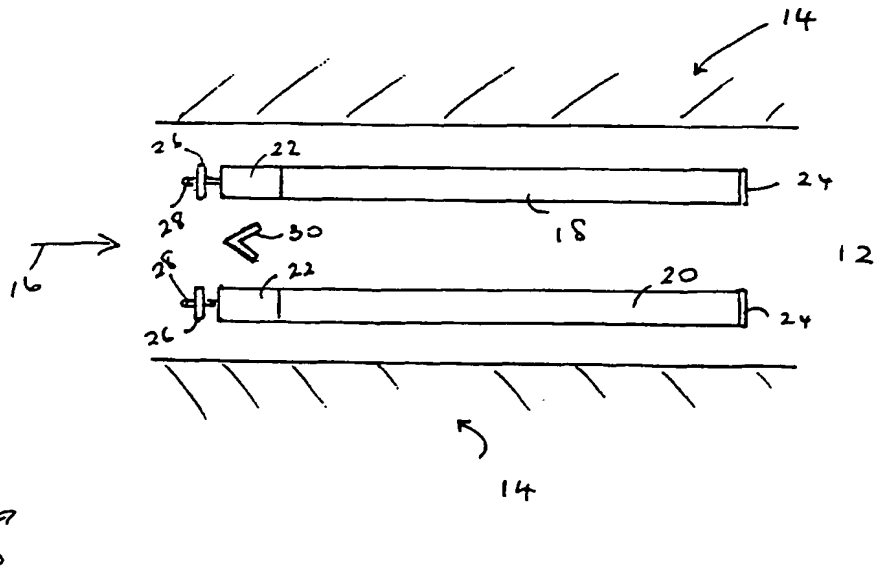
(54) Title: UV-IRRADIATION WATER PURIFICATION APPARATUS WITH TURBULENT FLOW



(57) Abstract: A water purification apparatus comprising a plurality of elongated ultraviolet lamp assemblies (18, 20) adapted to be immersed in water in an open channel (12) having water flowing longitudinally therethrough. The elongated ultraviolet lamp assemblies are supported by a frame (24). The ballasts (22) associated with the elongated ultraviolet lamp assemblies (18, 20) may be located above water level or immersed in water and adjacent to each elongated ultraviolet lamp assembly. At least one vortex generator (30) is located upstream of and juxtaposed to said elongated ultraviolet lamp assemblies. The at least one vortex generator (30) causes turbulence in the flow of water through the channel.

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UV-IRRADIATION WATER PURIFICATION APPARATUS WITH TURBULENT FLOW

FIELD OF THE INVENTION

The present invention relates to a water purification apparatus located in an open channel through which water to be treated is passed. In particular, the present invention relates to a water purification apparatus comprising racks of elongated ultraviolet lamp assemblies, in which there is turbulent flow of the water as it passes the elongated ultraviolet lamp assemblies. The turbulent flow is effected by baffles, flow devices or other turbulence generators that are located prior to i.e. upstream of, the elongated ultraviolet lamp assemblies.

As used herein, the expression "vortex generator" is used to include baffles, flow devices and other turbulence generators that are placed in the water to be treated.

BACKGROUND TO THE INVENTION

It is known to treat water with ultraviolet light in order to destroy undesirable bacteria and other micro-organisms. In a typical apparatus, rack assemblies with a vertical array of elongated ultraviolet lamps are used typically with several racks in a side-by-side arrangement. In such vertical arrays, the elongated ultraviolet lamps are oriented horizontally in the rack. The racks are located in an open channel through which water to be treated is passed. The ultraviolet lamps are enclosed in quartz sleeves.

The ability of an ultraviolet light treatment system to inactivate (kill) micro-organisms is a function of the UV fluence generated in the treatment system. The UV fluence is the product of the fluence rate and the time. The ability of ultraviolet light to penetrate wastewater, and hence treat the wastewater, is affected by the transmission of ultraviolet light. As the ultraviolet transmission from the lamp decreases, the fluence rate also decreases. Thus, for a particular ultraviolet lamp, the important

factors in the transmission of ultraviolet light include the age of the lamp, the degree of fouling of the lamps i.e. the degree of fouling of the quartz sleeve on the lamp, and the clarity of the wastewater that is being treated. Steps may be taken to clean the lamps and especially the quartz sleeve on the lamp, but the clarity of the water to be treated may be difficult or impossible to control. In addition, the amount of ultraviolet light obtainable from an ultraviolet lamp is limited. Thus, the consequence of the need to provide a UV fluence to efficiently and effectively treat the water is that there is a tendency and desire to place the ultraviolet lamps closer and closer together and/or to use more ultraviolet lamps.

A variety of apparatus with vertical arrays of elongated ultraviolet lamps are known. Examples include the apparatus disclosed in U.S. Patent 5,019,256. This patent discloses an ultraviolet lamp rack assembly comprising a vertical array of horizontally disposed ultraviolet lamps for the treatment of waste water. Variations of this assembly are disclosed in U.S. Patents 4,482,809, 4,872,980 and 5,006,244. Such apparatus have the ballast located above the water level. Apparatus with the ballast located under water and adjacent to the lamp is disclosed in U.S. Patent 6,193,939.

Apparatus is also known in which the elongated ultraviolet lamps are oriented vertically. For example, U.S. Patent 5,660,719 discloses an ultraviolet lamp rack assembly comprising an array of vertically disposed ultraviolet lamps for the treatment of fluids.

In order to kill microorganisms in water, it is necessary to subject the microorganisms to a minimum fluence of ultraviolet light. As noted above, the UV fluence is equal to the fluence rate multiplied by the time of exposure. As the microorganisms pass through a water purification apparatus, the microorganisms are subjected to a range of UV fluences, depending on the quality of the water and especially on the location of the microorganism with respect to the array of lamps.

A water purification apparatus is designed to produce an average fluence that is sufficient to kill the microorganisms. Nonetheless, the UV fluence that a particular microorganism is subjected to may vary over a wide range depending on the particular path that the microorganism takes as it passes through the reactor. In a poorly designed apparatus, microorganisms may be able to pass through the apparatus without being subjected to sufficient UV fluence to kill the microorganism.

Creation of turbulence within the zone of the apparatus in which treatment occurs is intended to prevent microorganisms from passing through without being subjected to at least the minimum UV fluence to kill the microorganism. Examples of methods to create turbulence include the use of ring-shaped devices e.g. washers, on the exterior surface of the elongated ultraviolet light assemblies as disclosed in published PCT application WO 98/29345, the use of distributors as disclosed in U.S. 4,952,376 and the use of baffles within a tube as disclosed in U.S. 4,304,996, U.S. 5,696,380 and 5,866,910.

While the foregoing methods and devices may provide some degree of turbulance, the turbulence is not sufficient to ensure that microorganisms are adequately subjected to UV fluence. Moreover, some of the devices are not convenient for use within an apparatus. Thus, improvements in the method of creation of turbulence would be useful.

SUMMARY OF THE INVENTION

The present invention is directed to an apparatus that effects the creation of turbulence in the treatment of water thus providing for more effective disinfection of wastewater.

Accordingly, one aspect of the present invention provides a water purification apparatus comprising a plurality of elongated ultraviolet lamp assemblies adapted to be immersed in water in an open channel having water flowing longitudinally therethrough, said elongated ultraviolet lamp

assemblies being supported by a frame, at least one vortex generator located upstream of and juxtaposed to said elongated ultraviolet lamp assemblies, said at least one vortex generator causing turbulence in the flow of water through the channel.

In a preferred embodiment of the apparatus of the invention, the vortex generator introduces turbulence in the flow of water past the elongated ultraviolet lamp assemblies, said turbulence including flow of water in a direction other than the longitudinal direction of flow of water through the channel. The resultant turbulent water flows about the elongated ultraviolet lamp assemblies in a manner to increase likelihood of any microorganisms present in the wastewater to be subject to UV treatment and thus killed.

In another embodiment, there are at least two racks of elongated lamp assemblies in a side-by-side relationship, said at least one vortex generator being aligned with space between said racks. In embodiments, each rack has a vortex generator aligned with spaces on each side of the rack. Alternatively, there are at least two racks of elongated ultraviolet lamp assemblies in a parallel spaced apart relationship, said at least one vortex generator being aligned with a rack.

In further embodiments, there are at least two vortex generators, said vortex generators being aligned vertically. At least one vortex generator may be aligned with the frame.

In a further embodiment, the vortex generator is a V-shaped baffle facing upstream in the channel.

In another embodiment, there are a plurality of elongated ultraviolet lamp assemblies and a corresponding plurality of vortex generators. Preferably, each elongated ultraviolet lamp assembly has a vortex generator associated therewith.

In another embodiment, the vortex generator is elongated, extending substantially for the height of the rack. The vortex generator may form part of the frame.

In embodiments, the vortex generator forms part of the frame of the water purification device, said vortex generator being V-shaped with the apex facing upstream.

In another embodiment, the vortex generator may be a plate with the leading edge perpendicular to flow of water, especially in which the plate effects lateral flow of water in the channel.

In further embodiments, at least some vortex generators are at different orientations from other vortex generators. It is within the scope of the present invention to use a combination of different shaped vortex generators with a single apparatus.

In preferred embodiments, the vortex generator is separable from the elongated ultraviolet lamp assembly for independent removal from the channel. In other embodiments, the vortex generator is located independently of said frame and said elongated ultraviolet lamp assemblies, said vortex generator being removable from said channel.

In further embodiments, the ballasts associated with each elongated ultraviolet lamp assemblies are immersed in the water adjacent to the elongated ultraviolet lamp assemblies or located above the level of water in the channel.

According to another aspect of the present invention is a radiation source assembly for use in a photochemical treatment of a fluid, the radiation source assembly being adapted to be immersed in water in an open channel having water flowing longitudinally therethrough, the assembly comprising:

a plurality of radiation sources adapted to be immersed in said fluid when the assembly is in use;

an excitation controlling means mechanically and electrically connected to each radiation source, said excitation controlling means being adjacent to the radiation source, said excitation controlling means being adapted to be immersed in and cooled by said fluid when the assembly is in use;

an elongate frame member having a portion adapted to be immersed in the fluid when the assembly is in use, the frame member being connected to at least one of the ultraviolet lamp and the excitation controlling means;

electrical conducting means for providing electrical energy to the excitation controlling means; and

at least vortex generator located upstream and juxtaposed to said radiation sources, said vortex generator creating turbulence in the flow of water through the channel.

According to another aspect of the present invention is a method for the photochemical treatment of water in a water purification apparatus comprising a plurality of elongated ultraviolet lamp assemblies supported by a frame and adapted to be immersed in water in an open channel having water flowing longitudinally therethrough, and at least one vortex generator located upstream of and juxtaposed to said elongated ultraviolet lamp assemblies, said method comprising redirecting longitudinally flowing water in a turbulent pattern towards and about said elongated ultraviolet lamp assemblies and throughout said channel, such that any microorganism present in said water is destroyed.

Other features and advantages of the present invention will become apparent from the following detailed description. It should be understood, however, that the detailed description and the specific examples while indicating embodiments of the invention are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from said detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by the embodiment shown in the drawings, in which:

Figure 1 is a schematic representation of a plan view of racks of lamps in a channel, with a vortex generator of the present invention;

Figure 2 is a schematic representation of a plan view of racks of lamps in a channel, with vortex generators of the present invention;

Figure 3 is a schematic representation of a plan view of racks of lamps in a channel, with vortex generators of the present invention;

Figure 4 is a schematic representation of a plan view of racks of lamps in a channel, with vortex generators of the present invention;

Figure 5 is a schematic representation of a vertical cross section of an embodiment of the present invention;

Figure 6 is a schematic representation of a vertical cross section of a second embodiment of the present invention;

Figure 7 is a schematic representation of a variation of the embodiment of Figure 5; and

Figure 8 is a schematic representation of a variation of the embodiment of Figure 6.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a water purification apparatus that has a plurality of elongated ultraviolet lamp assemblies attached to a frame and which are adapted to be immersed in water in an open channel. Water flows through the open channel longitudinally i.e. in the same direction as the orientation of the elongated lamp assemblies. Each elongated lamp assembly has a ballast associated therewith, which may be located above the water level or located adjacent to the elongated ultraviolet lamp assembly and immersed in the water. The apparatus of the present invention has a least one vortex generator located upstream of the elongated lamp assembly, but juxtaposed to the lamp assemblies so that the vortex created in the water provides turbulence at the elongated lamp assemblies. In particular, the vortex generator creates

flow of water in a direction other than the longitudinal direction of flow of water through the channel.

One embodiment of apparatus 10 of the present invention is shown in Figure 1, which is a cross-section of a plan view of apparatus of the present invention. Apparatus 10 is located in channel 12 which is formed between walls 14. The flow of water in channel 12 is indicated by arrow 16. Apparatus 10 is shown as having first lamp 18 and second lamp 20. First lamp 18 would form part of a rack of lamps disposed in a vertical array in channel 12. Similarly, second lamp 20 would form part of a second rack of lamps in channel 12. It is understood that more than two racks of lamps could be located in channel 12, and that racks of lamps would normally be disposed across the width of channel 12, and typically spaced apart by distances 5-15 cm. The lamps are shown as being aligned with the longitudinal direction of flow of water through the channel. All lamps typically have a quartz sleeve, generally a quartz sleeve with one closed end.

In the embodiments shown in Figure 1, each lamp has a ballast 22 directly connected to the lamp, and located under water with the lamp. First lamp 18 and second lamp 20 are attached to frame ends 24 and 26, which support the lamps in position. Ballast 22 is connected to electrical conduits 28 which pass through frame leg 26. It is understood that other arrangements of lamps and ballasts may be used, especially with the ballast located above water, as is known in the art.

In Figure 1, vortex generator 30 is shown as located between first lamp 18 and second lamp 20. In Figure 1, vortex generator 30 is shown in the form of V-shaped baffle that extends vertically between first lamp 18 and second lamp 20. Vortex generator 30 is located upstream of first lamp 18 and second lamp 20, so that turbulence is created in the region of first lamp 18 and second lamp 20. In the embodiments shown, vortex generator 30 is shown as located adjacent to ballasts 22, but it

understood that vortex generator 30 could be located further upstream than indicated in Figure 1, as is shown in Figure 4.

In operation, water flowing through channel 12 in the direction of arrow 16 is diverted from the longitudinal direction of flow through channel 12 so that there is flow of water laterally across lamps 18 and 20, thereby creating turbulence in the flow of water through channel 12.

Figure 2 shows apparatus 36 which is similar to the apparatus of Figure 1, except that first angled baffle 32 has been located between first lamp 18 and channel wall 14. Similarly, second angled baffle 34 is shown as located between second lamp 20 and wall 14. First angled baffle 32 and second angled baffle 34 are shown as diverting the flow of water inwards in channel 12 towards the respective first lamp 18 and second lamp 20. It is understood that first angled baffle 32 and second angled baffle 34 could be oriented in the opposite direction or could be in a shape other than that shown in Figure 2.

Figure 3 shows another embodiment of the present invention, indicated by apparatus 40. In Figure 3, apparatus 40 is shown as having first lamp 42 and second lamp 44 located in channel 12, and held in position by frame ends 46 and 48. The embodiments of Figure 3 illustrate use of the present invention with a lamp assembly in which the ballast is not located under water with electrical leads passing from lamps 42 and 44 up frame 48. Figure 3 also shows an embodiment of the present invention in which vortex generator 50 and 52 are located on frame 48, in a position aligned longitudinally with lamps 42 and 44. It is understood that vortex generators 50 and 52 could be utilized with apparatus of the type shown in Figure 1 and Figure 2, and conversely vortex generators of the type shown in Figure 1 and Figure 2 could be used with apparatus of the type shown in Figure 3.

In operation, vortex generators 50 and 52 divert the flow of water from the longitudinal direction through channel 12 causing turbulence in the water around lamps 42 and 44.

Figure 4 shows apparatus 54 having a lamp assembly of the type shown in Figure 3. In Figure 4, vortex generator 56 is centrally located between lamps 42 and 44 in a position that is forward of the position of such lamps. In addition, vortex generators 58 and 60 are shown in position between lamp 42 and wall 14 and lamp 44 and wall 14, respectively. In Figure 4, vortex generator 56 is shown as being of a different shape than vortex generators 58 and 60, although both are shown as V-shaped baffles.

Figure 5 shows a cross section of apparatus 54 through A-A. Apparatus 54 is shown as having a plurality of lamps 42A-42D shown in a vertical array. Lamps 42A-42D are shown as attached to frame 46 and 48. Frame 46 and 48 has upper frame section 62 which is above water level 64. Vortex generator 56 is shown as attached to upper frame 52 by bracket 66. Vortex generator 56 extends downward from water level 64 to close to the bottom 68 of channel 12.

Figure 6 shows an another embodiment of the apparatus shown in Figure 5, in which vortex generator 56 is shown has having sections 56A, 56B, 56C and 56D. Vortex generator sections 56A-56D are held in position by brackets 70A-70C that extend between sections 56A-56D. Figure 5 represents an embodiment in which the vortex generator 56 extends from water level 64 down to near the bottom 68 of channel 12, whereas Figure 6 shows an embodiment in which the vortex generator 56 is in sections that are held together by brackets. It is understood that the sections 56A-56D could be aligned with the respective lamps 42A-42D, or could be at other locations i.e. not aligned with the lamps.

Figure 7 and 8 show variations on the embodiments of Figures 5 and 6, respectively, in which the vortex generators are not attached to upper frame section 62. In each instance, the vortex generators 56 and 56A-56D are separate from upper frame section 62, being supported by other structure related to the water treatment system and not shown. For instance, bracket 72 could be attached to walkways above frame 62,

buildings or other structure of the water treatment system. Such alternate means of attachment could facilitate the easy removal and cleaning of the vortex generators.

The vortex generators have been shown therein as being V-shaped baffles. It is understood that other shapes can be used. The vortex generators have been shown as having linear sides, connected to a V-shape but the vortex generators could have other shapes e.g. have curved sides, including sides that are curved to additionally direct water upwards and downwards within the channel or of other shapes that create turbulence.

The vortex generators of the present invention are not located between the lamps. In particular, the vortex generators are located upstream from the lamps, in positions that will create turbulence around the lamps. As illustrated, the vortex generators may be located adjacent to ballasts attached to the lamps, in those embodiments in which the ballast is under water. The vortex generators may also be located upstream from the frame holding the lamp assembly. The vortex generators may be located in positions directly aligned with sections of the frame holding the lamp assemblies or in positions that are aligned with the spaces between the lamps of the lamp assemblies.

The vortex generators may be attached to the frame of the lamp assemblies. However, in preferred embodiments of the present invention, the vortex generators are attached to the frame in a manner that permits the vortex generators to be removed from the channel without requiring that the lamp assemblies be removed from the channel. In this manner, it is possible to separately remove the vortex generators for cleaning if the vortex generators should become contaminated with debris that is in the channel.

The vortex generators of the present invention are not located on or between the lamps of the lamp assemblies and consequently do not

obstruct the fluence of light passing from the lamps into the water that is being treated. Thus, the fluence rates of the lamps are not reduced.

The vortex generators may be incorporated in new racks of lamp assemblies that are being installed, or may be retro-fitted to pre-existing ultraviolet lamp treatment systems. The vortex generators are easily installed, and easily removed for cleaning. They are also simple and economical to manufacture.

Creation of turbulence permits the use of wider spacing between the lamps. This lowers the overall head loss of the ultraviolet purification treatment system, and allows the treatment of more water per lamp. Consequently, the ultraviolet water treatment system is more cost effective.

Although preferred embodiments of the invention have been described herein in detail, it will be understood by those skilled in the art that variations may be made thereto without departing from the spirit of the invention or the scope of the appended claims.

CLAIMS:

1. A water purification apparatus comprising a plurality of elongated ultraviolet lamp assemblies adapted to be immersed in water in an open channel having water flowing longitudinally therethrough, said elongated ultraviolet lamp assemblies being supported by a frame, at least one vortex generator located upstream of and juxtaposed to said elongated ultraviolet lamp assemblies, said at least one vortex generator causing turbulence in the flow of water through the channel.

2. The water purification apparatus of Claim 1 in which the vortex generator introduces turbulence in the flow of water past the elongated ultraviolet lamp assemblies, said turbulence including flow of water in a direction other than the longitudinal direction of flow of water through the channel.

3. The water purification apparatus of Claim 1 or 2 in which there are at least two racks of elongated ultraviolet lamp assemblies in a side-by-side relationship, said at least one vortex generator being aligned with space between said racks.

4. The water purification apparatus of Claim 3 in which each rack has a vortex generator aligned with spaces on each side of the rack.

5. The water purification apparatus of Claim 2 in which there are at least two racks of elongated ultraviolet lamp assemblies in a parallel spaced apart relationship, said at least one vortex generator being aligned with a rack.

6. The water purification apparatus of Claim 3 in which there are at least two vortex generators, said vortex generators being aligned vertically.

7. The water purification apparatus of Claim 2 in which at least one vortex generator is aligned with the frame.

8. The water purification apparatus of Claim 2 in which the vortex generator is a V-shaped baffle facing upstream in the channel.

9. The water purification apparatus of Claim 3 in which there are a plurality of elongated ultraviolet lamp assemblies and a corresponding plurality of vortex generators.

10. The water purification apparatus of Claim 2 in which each elongated ultraviolet lamp assembly has a vortex generator associated therewith.

11. The water purification apparatus of Claim 2 in which there is a vortex generator aligned with each space between elongated ultraviolet lamp assemblies.

12. The water purification apparatus of Claim 2 in which the vortex generator is elongated, extending substantially for the height of the rack.

13. The water purification apparatus of Claim 12 in which the vortex generator forms part of the frame.

14. The water purification apparatus of Claim 2 in which the vortex generator forms part of the frame of the water purification device, said vortex generator being V-shaped with the apex facing upstream.

15. The water purification apparatus of Claim 2 in which the vortex generator is in a shape other than V-shaped.

16. The water purification apparatus of Claim 2 in which the vortex generator is a plate with the leading edge perpendicular to flow of water.

17. The water purification apparatus of Claim 16 in which the plate effects lateral flow of water in the channel.

18. The water purification apparatus of Claim 16 in which at least some vortex generators are at different orientations from other vortex generators.

19. The water purification apparatus of Claim 1 in which the vortex generator is separable from the elongated lamp assembly for independent removal from the channel.

20. The water purification apparatus of Claim 1 in which the vortex generator is located independently of said frame and said elongated ultraviolet lamp assemblies, said vortex generator being removable from said channel.

21. The water purification apparatus of Claim 1 in which each of said elongated lamp assemblies has a ballast associated therewith, said ballasts being immersed in said water and adjacent to the respective elongated ultraviolet lamp assembly.

22. The water purification apparatus of Claim 1 in which each of said elongated lamp assemblies have a ballast associated therewith, said ballasts being located above the water in the channel.

23. A radiation source assembly for use in a photochemical treatment of a fluid, the radiation source assembly being adapted to be immersed in water in an open channel having water flowing longitudinally therethrough, the assembly comprising:

a plurality of elongated radiation sources adapted to be immersed in said fluid when the assembly is in use;

an excitation controlling means mechanically and electrically connected to each radiation source, said excitation controlling means being adjacent to the radiation source, said excitation controlling means being adapted to be immersed in and cooled by said fluid when the assembly is in use;

an elongate frame member having a portion adapted to be immersed in the fluid when the assembly is in use, the frame member being connected to at least one of the ultraviolet lamp and the excitation controlling means;

electrical conducting means for providing electrical energy to the excitation controlling means; and

at least vortex generator located upstream and juxtaposed to said radiation sources, said vortex generator creating turbulence in the flow of fluid through the channel.

24. The radiation source assembly of Claim 23 in which the vortex generator introduces turbulence in the flow of fluid past the elongated radiation sources, said turbulence including flow of fluid in a direction other than the longitudinal direction of flow of fluid through the channel.

25. The radiation source assembly of Claim 24 in which there are at least two racks of elongated radiation sources in a side-by-side relationship, said at least one vortex generator being aligned within space between said racks.

26. The radiation source assembly of Claim 25 in which each rack has a vortex generator aligned with spaces on each side of the rack.

27. The radiation source assembly of Claim 24 or 26 in which there are at least two vortex generators, said vortex generators being aligned vertically.

28. The radiation source assembly of Claim 27 in which at least one vortex generator is aligned with the frame.

29. The radiation source assembly of Claim 28 in which the vortex generator is a V-shaped baffle facing upstream in the channel.

30. The radiation source assembly of Claim 29 in which each elongated ultraviolet lamp assembly has a vortex generator associated therewith.

31. The radiation source assembly of Claim 24 in which the vortex generator is elongated, extending substantially for the height of the rack.

32. The radiation source assembly of Claim 23 or 31 in which the vortex generator forms part of the frame.

33. The radiation source assembly of Claim 24 in which the vortex generator forms part of the frame of the water purification device, said vortex generator being V-shaped with the apex facing upstream.

34. The radiation source assembly of any one of Claims 23 to 33 in which the vortex generator is in a shape other than V-shaped.

35. The radiation source assembly of Claim 34 in which at least some vortex generators are at different orientations from other vortex generators.

36. The radiation source assembly of Claim 23 in which the vortex generator is separable from the elongated lamp assembly for independent removal from the channel.

37. A method for the photochemical treatment of water in a water purification apparatus comprising a plurality of elongated ultraviolet lamp assemblies supported by a frame and adapted to be immersed in water in an open channel having water flowing longitudinally therethrough, and at least one vortex generator located upstream of and juxtaposed to said elongated ultraviolet lamp assemblies, said method comprising redirecting longitudinally flowing water in a turbulent pattern towards and about said elongated ultraviolet lamp assemblies and throughout said channel, such that any microorganism present in said water is destroyed.

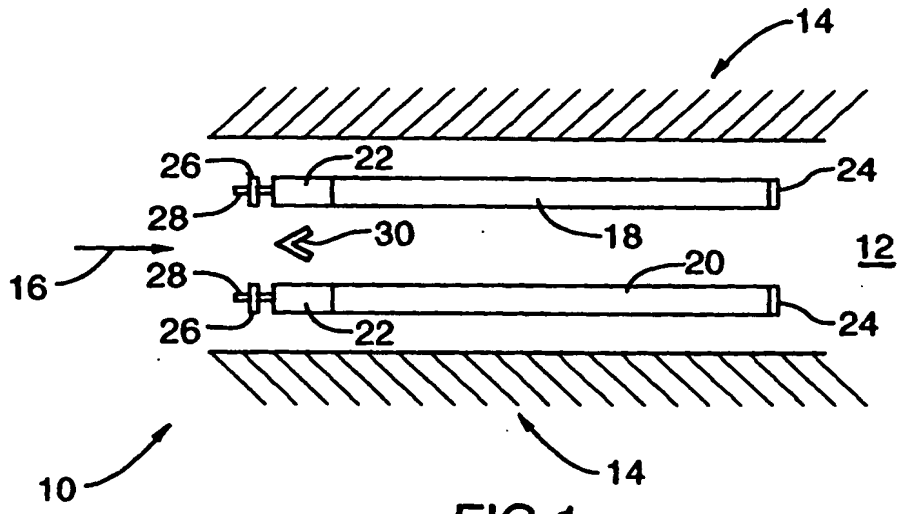

FIG.1

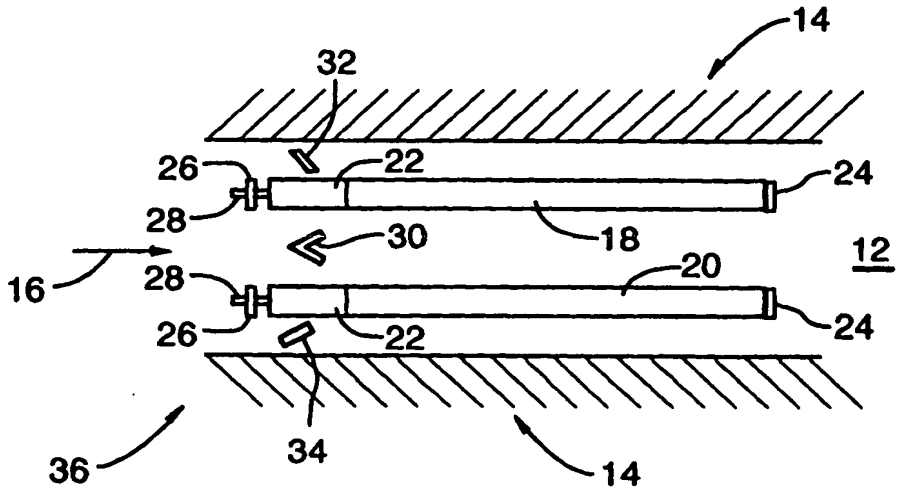

FIG.2

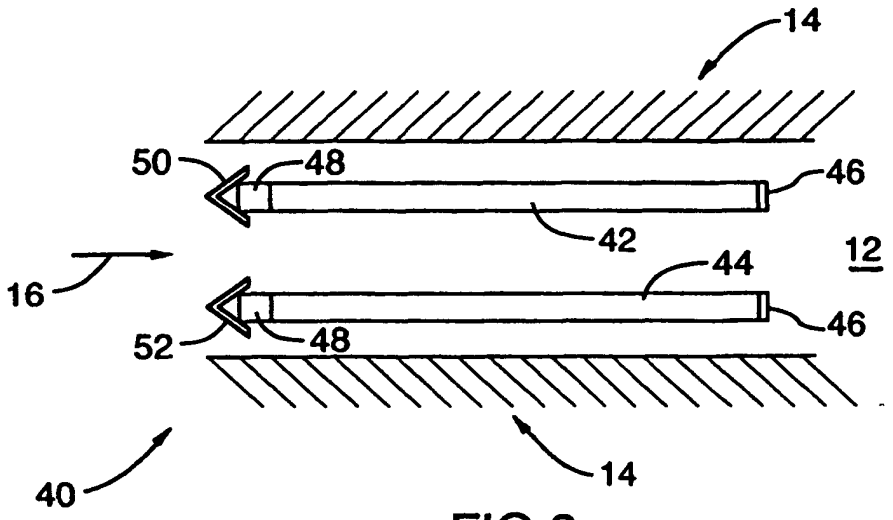

FIG.3

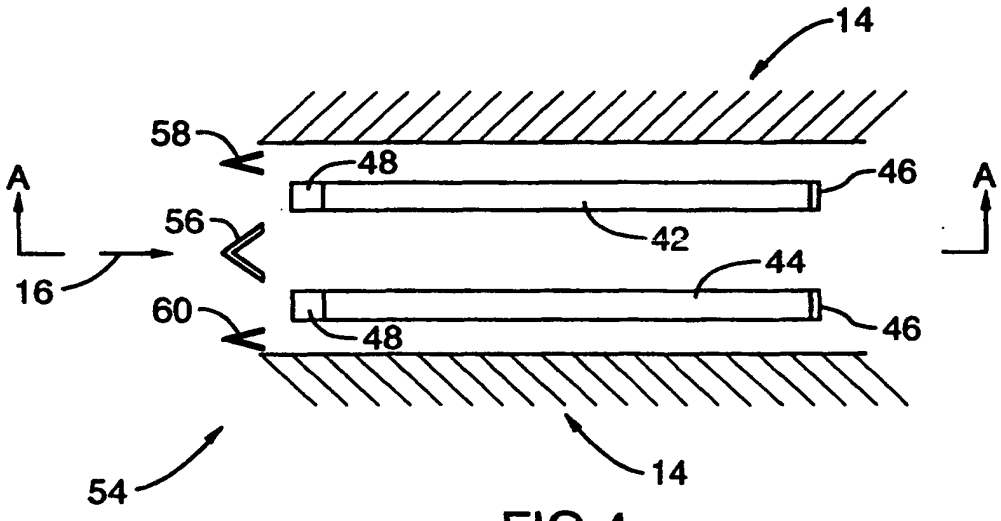

FIG.4

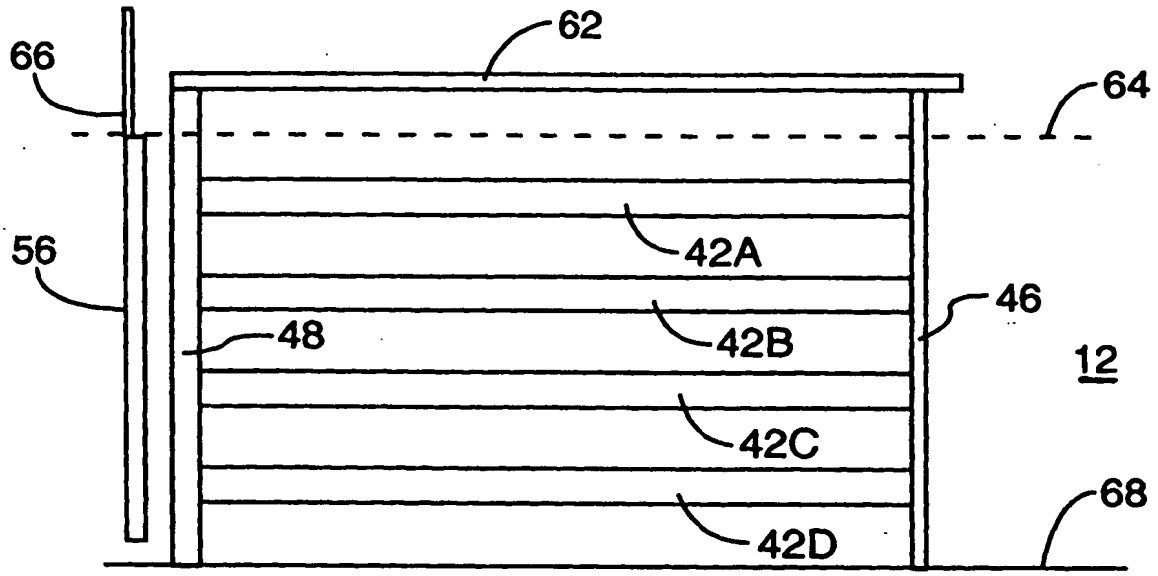

FIG.7

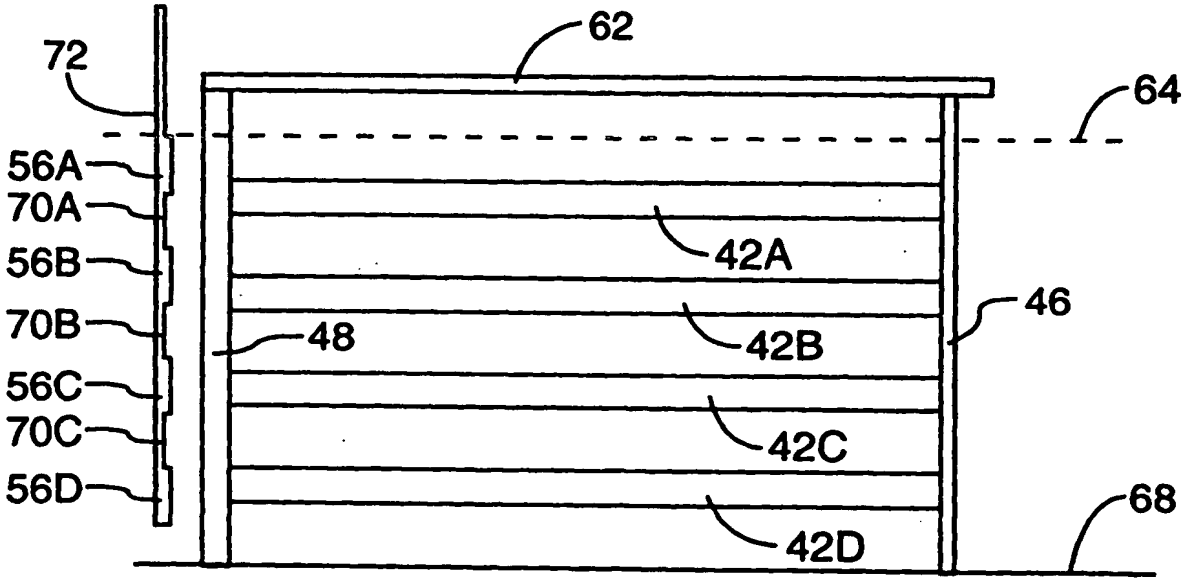

FIG.8

INTERNATIONAL SEARCH REPORT

Inte nal Application No
PCT/CA 02/00319

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C02F1/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 015 229 A (BIRCHER KEITH ET AL) 18 January 2000 (2000-01-18) column 1, line 47 - line 67; figure 1 column 3, line 35 -column 4, line 47; figures 2A,2,B	1-37
P,X	WO 01 93995 A (TROJAN TECHN INC) 13 December 2001 (2001-12-13) page 4, line 1 -page 20, line 5; figures 1-18C	1-37
A	EP 0 317 735 A (KATADYN PRODUKTE AG) 31 May 1989 (1989-05-31) the whole document	1-37
A	US 5 503 800 A (FREE DAVID) 2 April 1996 (1996-04-02) the whole document	1-37

-/--

[X] Further documents are listed in the continuation of box C.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 893 411 A (INFILCO DEGREMONT INC) 27 January 1999 (1999-01-27) the whole document ---	1-37
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 02, 30 January 1998 (1998-01-30) & JP 09 276859 A (NIPPON PHOTO SCI:KK), 28 October 1997 (1997-10-28) abstract -----	1-37

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INTERNATIONAL SEARCH REPORT

rmation on patent family members

Inte pnal Application No
PCT/CA 02/00319

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6015229 A	18-01-2000	BR 9812824 A	08-08-2000
		CA 2303944 A1	25-03-1999
		CN 1276743 T	13-12-2000
		EP 1024888 A1	09-08-2000
		JP 2001516637 T	02-10-2001
		NO 20001427 A	18-05-2000
		WO 9913975 A1	25-03-1999
WO 0193995 A	13-12-2001	AU 6718701 A	17-12-2001
		WO 0193995 A2	13-12-2001
		US 2002036951 A1	28-03-2002
EP 0317735 A	31-05-1989	DE 3740005 A1	08-06-1989
		EP 0317735 A2	31-05-1989
US 5503800 A	02-04-1996	NONE	
EP 0893411 A	27-01-1999	US 5952663 A	14-09-1999
		EP 0893411 A1	27-01-1999
JP 09276859 A	28-10-1997	NONE	